Civilian Research Project
Senior Service College Fellow

Securing Our Transportation Future Through Changes to the Energy Model

by

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United States Army War College
Class of 2012

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REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. REPORT DATE *(DD-MM-YYYY)*	**2. REPORT TYPE**	**3. DATES COVERED** *(From - To)*
10-05-2011	Civilian Research Paper	

4. TITLE AND SUBTITLE
Securing Our Transportation Future Through Changes to the Energy Model

5a. CONTRACT NUMBER

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)

COL Michael Ahn

5d. PROJECT NUMBER

5e. TASK NUMBER

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

Army Environmental Policy Institute
Building 1458
9301 Chapek Road
Fort Belvoir, VA 22060

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)

U.S. Army War College
77 Forbes Ave.
Carlisle, PA 17013

10. SPONSOR/MONITOR'S ACRONYM(S)

11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION / AVAILABILITY STATEMENT
Distribution A: Unlimited

13. SUPPLEMENTARY NOTES

14. ABSTRACT

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15. SUBJECT TERMS
Alternative Energy, Renewable Energy, Research and Development

16. SECURITY CLASSIFICATION OF:			**17. LIMITATION OF ABSTRACT**	**18. NUMBER OF PAGES**	**19a. NAME OF RESPONSIBLE PERSON**
a. REPORT	**b. ABSTRACT**	**c. THIS PAGE**			**19b. TELEPHONE NUMBER** *(include area code)*
Unclassified	Unclassified	Unclassified	Unlimited	32	

USAWC CIVILIAN RESEARCH PROJECT

SECURING OUR TRANSPORTATION FUTURE THROUGH CHANGES TO THE ENERGY MODEL

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This CRP is submitted in partial fulfillment of the requirements of the Senior Service College fellowship. The U.S. Army War College is accredited by the Commission on Higher Education of the Middle States Association of Colleges and Schools, 3624 Market Street, Philadelphia, PA 19104, (215) 662-5606. The Commission on Higher Education is an institutional accrediting agency recognized by the U.S. Secretary of Education and the Council for Higher Education Accreditation.

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CARLISLE BARRACKS, PENNSYLVANIA 17013

ABSTRACT

AUTHOR: COL Michael Ahn

TITLE: Securing Our Transportation Future Through Changes to the Energy Model

FORMAT: Civilian Research Project

DATE: 10 May 2012 WORD COUNT: 4,948 PAGES: 32

KEY TERMS: Alternative Energy, Renewable Energy, Research and Development

CLASSIFICATION: Unclassified

Transportation is the lifeblood of any modern society. Without the ability to economically transport people and goods throughout the country, the standard of living for each citizen would decline. Today, with the rising cost of fossil fuels, transportation costs are skyrocketing making the price of basic goods almost unaffordable for the ordinary citizen. This places a heavy strain not only on our economy, but to our national security as so much of our commerce and military depend on oil as the transportation fuel. This paper will first discuss the economic and security issues with respect to the current dependency on oil as the primary transportation fuel. Existing United States' energy policies within the various federal Departments will then be reviewed. This will be followed by a review of the current transportation energy processes that the Department of Defense and Department of Energy are working on to reduce the dependency on oil as the main transportation fuel. Finally, the paper will provide a plan and justification for the investigation of an alternative energy model for transportation fuel to include policy and funding changes needed to make the United States more economically competitive and ensure a more secure future for its citizens.

Securing Our Transportation Future Through Changes to the Energy Model

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SECURING OUR TRANSPORTATION FUTURE THROUGH CHANGES TO THE ENERGY MODEL

Section 1: Dependency of Oil as the Primary Transportation Fuel: Is There Still Enough?

Transportation is the lifeblood of any modern society. Without the ability to economically transport people and goods throughout the country, the standard of living for each citizen would decline. Today, with the rising cost of fossil fuels, transportation costs are skyrocketing making the price of basic goods almost unaffordable for the ordinary citizen. With oil as the predominate fuel for transportation, the cost to provide these basic goods will continue to increase. This places a heavy strain not only on our economy, but to our national security as so much of our commerce and military depend on oil as the transportation fuel. This paper will first discuss the economic and security issues with respect to the current dependency on oil as the primary transportation fuel. In order to understand the current status of these issues, an examination of existing United States' energy policies within the various federal Departments will then be reviewed. This will be followed by a review of the current transportation energy processes that the Department of Defense and Department of Energy are working on to reduce the dependency on oil as the main transportation fuel. Finally, the paper will provide a plan and justification for the investigation of an alternative energy model for transportation fuel to include policy and funding changes needed to make the United States more economically competitive and ensure a more secure future for its citizens.

The necessity for different energy transportation options has never been greater given the current political and military operational climate of today. Oil is the choice for 95% of the United States transportation energy source with nearly half of that imported.[1] The United States military singlehandedly consumes more energy than 85% of all nations and is the world's largest institutional oil buyer.[2] More than 50% of the oil ever used has been consumed since 1986 and more than 95% of the world's total consumption has occurred since the beginning of the Second World War.[3]

The cumulative total consumption of 1.16 trillion barrels at the end of 2008 appears to be approaching half the oil that could ever be extracted.[4] Estimates vary on the amount of extractable oil still left. The literature has the consumption of oil at now three or more times the rate of discovery [5] with a peak production of all petroleum liquids by 2012.[6] Other estimates state that we had already reached peak oil production in 1970.[7] By the 2030s, world oil requirements could go from 86 to 118 million barrels a day (MBD).[8] Even if one does not believe that there is a lack of petroleum reserves, a shortage of drilling platforms, engineers and refining capacity will curtail oil production in the coming decades.[9] A concerted effort begun today to repair this shortage would still be at least ten years away before production could catch up with expected demand.[10]

Section 2: Dependency of Oil as the Primary Transportation Fuel: National Security Issues

The United States economy as well as its national security has always been dependent on cheap and reliable oil for its transportation needs. Yet the United States,

for many decades, continues to import large amounts of oil, currently at 1.5 billion barrels a year, from the nations that the State Department lists as dangerous and unstable and a major threat to national as well as economic security.[11] The United States sends approximately $1 billion overseas every day for imported oil, expenditure that represents a significant part of the trade deficit and often causes hardship for American consumers and businesses. [12] Some of these oil producing nations are suspected in utilizing their oil revenue to sponsor terrorist activities against the United States.[13] The United States' foreign oil reliance not only undermines national security by enriching these hostile regimes, but requires our military forces to be deployed to protect access to oil.[14]

The current Arab Spring as well as China's and India's increased energy demands and ability to forge alliances with oil and rare mineral producing nations also stresses the urgency to finding a different transportation energy source. The Chinese are laying down approximately 1,000 kilometers of four-lane highway every year, a figure suggestive of how many more vehicles they expect to possess, with the concomitant rise in their demand for oil.[15] The presence of Chinese "civilians" in the Sudan to guard oil pipelines underlines China's concern for protecting its oil supplies and could portend a future in which other states intervene in Africa to protect scarce oil and rare earth mineral resources.[16] In fact, Asia itself has become the center of global energy and commodity markets as demand for oil and rare minerals mirror their rapid economic growth.[17] Thus, the increased competition for access and control of oil may lead to increased political tensions between the United States and China as well as

India.[18] These tensions could possibly lead to the use of military force to ensure access to oil supplies.[19]

From the military operational view, the need for alternative sources of energy was brought out in the lessons learned from the current missions in Iraq and Afghanistan. The 2008 Department of Defense Science Board determined that the most significant energy-related risk to DoD's combat capability is the burden of moving fuel from the point of commercial purchase to the combat systems that need it.[20] In fact, the primary threat to the mission is the hazards associated with supply convoy operations. Moving a large quantity of fuel and water for military operations entails a great deal of logistical and tactical risks.[21] From Fiscal Year 2003 to 2007 in Iraq and Afghanistan, a total of more than 3,000 Army personnel and contractors were wounded or killed in actions from attacks on fuel and water resupply convoys. [22] In 2010, United States Transportation Command reported that ground convoys were attacked 1,100 times in 2010 resulting in some fuel deliveries to be made by air at a cost of ten times the expense of ground transportation.[23] The financial cost also impacts national security. In 2010 the Department of Defense consumed overall nearly five billion gallons of petroleum in military operations, costing $13.2 billion dollars which is a 255 percent increase over 1997 prices.[24]

Section 3: Current Energy Transportation Policies

From a policy standpoint, both the Department of Energy (DOE) and Department of Defense (DOD) recognize these dangers in the dependence of oil as the primary fuel

for transportation and are taking steps to diversify this country's transportation energy options. DOE understands that the reliance on oil is the greatest immediate threat to U.S. economic and national security.[25] DOE also recognized that their current policies underinvest in the transportation sector relative to the stationary sector. (energy efficiency, grid, and electric power)[26] DOE's plan to reach President Obama's goal of reducing oil imports by one-third by 2025 , includes three activity principles : 1) Focus on activities with the greatest potential to reduce oil consumption such as improving vehicle efficiency and promote the use of alternative sources for transportation energy, 2) support transportation technologies that can integrate smoothly with existing infrastructure such as vehicle electrification, and 3) pursue only transport technologies that also reduce environmental impact.[27]

DOD, to include the Department of the Army (DA), also has goals that focus on the reduction of oil consumption and the investigation of alternative fuels. In order to begin this process, the DOD has started to quantify the fully burden cost of fuel and energy to attempt to understand the best practices to reduce oil consumptions and investigate alternative energy sources. These costs include obtaining, storage, transportation and security of these assets as well as the environmental and health costs associated with the use of oil as the primary transportation energy source. DOD's Operational Energy Strategic Goals align with both the 2010 Quadrennial Defense Review (QDR) and the DOE strategy focuses. The 2010 QDR has energy security as one of the four issues that the DOD needs to reform how they do business.[28] To this end, the 2010 QDR focuses on energy efficiency and alternative fuels.[29]

The DOD Operational Energy Strategy outlines three principles: 1) More fight, less fuel: Reduce the demand for energy in military operations through improved efficiencies, 2) More options, less risk: Expand and secure a more diverse supply of energy to military operations, and 3) More capability, less cost: Build energy security into the future force.[30] The Army Energy Security Implementation Strategy (AESIS) has five strategic goals that align with the DOD Operational Energy Strategic Goals as well as the DOE strategy focuses. These five strategic goals include: 1) Reduce Energy Consumption, 2) Increased Energy Efficiency Across Platforms and Facilities, 3) Increase Use of Renewable / Alternative Energy, 4) Assured Access to Sufficient Energy Supplies, and 5) Reduce Adverse Impacts on the Environment.[31]

To further advance research, DOD has also signed a Memorandum of Understanding (MOU) with the Department of Energy (DOE) on 22 July 2010 that allows research collaboration between the two Departments in the advancement of energy efficiency, renewable energy, alternative fuels, efficient transportation technologies, and basic science research.[32] However, while the spirit of the MOU has future promise of cooperation, both the DOE and DOD have been working financially independently while partnering with private industry on specific Department projects focused on their specific goals. Joint goals, policies or investment strategies still need to be established between the two Departments.

Section 4: Contributing But Competing Transportation Energy Alternatives: Are We any Closer to a Solution?

DOE's Oak Ridge National Laboratory has partnered with BMI Corporation of Greenville South Carolina to develop a simulated "Smart Truck" that has higher fuel efficiency. [33]In particular, the software has retrofitting existing trucks with aerodynamic wheel fairings, a special sled attached to the axles to air direct flow under the suspensions and a rear diffuser to optimize air flow and boost fuel efficiency by 12% to potentially 50%[34]. That means that the average truck should get 6.72 to up to 12 more miles per gallon reducing the potential to import .75 billion barrels a year instead of the current 1.5 billion barrels a year.[35] DOE had in the past partnered with the coal and gas industry to produce synthetic fuels. However, these projects were either cancelled due to a downturn in oil prices or the industry backed away from the project due to an unacceptable rate or return on their investment.[36]

The Department of Defense (DOD) has been working on projects whose end state may also have civilian applications. The goal for alternative fuels is to be able to substitute for one or more of the three main petroleum based fuels that currently support the majority of the military operations: Jet Propellant 5 and 8 (JP 5 and 8) and Naval Distillate (F-76). One of the two major alternative fuels that are being investigated is a the Fisher Tropsch process which includes a 50/50 blend of JP8 and synthetic fuel made from coal or natural gas for B52s and C17s.[37] The Air Force has just completed a $35 million project that successfully tested this blend for the TF-33 engines on B-52

aircraft.[38] As JP8 is primarily used for jet fuel, any advancement in the blending of JP8 and synthetic fuel may have even further application for the airline and possibly trucking industry as well as for Army tanks.

Another example of an alternative fuel initiative is the Navy's research on the use of algae as biofuels for their ships. In October 2009, Navy Secretary Ray Mabus committed the Navy and Marine Corps to "creating a *Green Strike Group* composed of nuclear vessels and ships powered by biofuels" by 2012 and deploying it by 2016.[39] By 2020, at least 50 percent of the energy the Navy consumes is to come from alternative sources.[40]

The Army has also been researching the Badenoch vehicle as a lighter, much more fuel efficient replacement for the High Mobility Multipurpose Wheeled Vehicle (HMMWV). The Badenoch can carry as much weight and personnel as the uploaded HMMWV at half the weight itself.[41] This, while also affording the same force protection while achieving a 50% increase in fuel efficiency in wartime conditions when fitted with a hybrid electric and an Opposed Piston Opposed engine technology..[42] This would increase the gas mileage from 4 miles per gallon to 8 miles per gallon.

However, what the Department of Defense does best is utilize the Defense Advanced Research Projects Agency (DARPA), to bridge the needs of the federal government with the abilities of private industry to bring innovations to market. DARPA was created in 1957 in response to the Cold War and Sputnik to champion revolutionary technologies through basic research to solve specific technological challenges.[43] In

particular, DARPA is known for linking research advances with private sector adoptions of such technologies.[44] One of DARPA's most recent successes was their collaboration with Sematech in regaining for the United States the leadership position in semiconductor manufacturing from Japan in the 1980s.[45] DARPA was also the agency that contracted for ARPAnet in 1969 which led to widespread Internet use in the 1990s.[46] Both of these military initiatives eventually led to huge civilian applications that boosted the United States economy and global security.

Despite these DOD and DOE policies and initiatives, significant advances for alternatives or optimization processes to oil have not been reached. These "Nobel level" breakthroughs, which Secretary of Energy Chu stated we need across several energy technologies to solve the energy challenge[47] will need to take a different approach than the current policies and projects that are currently in place. None of the DOE or DOD projects are ready for large scale commercial development. Over the next 15 years, Fisher-Tropsch fuels are unlikely to constitute more than a few percent of total global production of middle distillates making them of little benefit to the military.[48] While algae based fuels may well be compatible for DOD transportation uses, both the 2011 Rand Study[49] and the 2008 Defense Science Board[50] believe that algae derived fuels are more of a research topic and not an emerging option for transportation operations. Furthermore, the production of this type of fuel may be limited to 30,000 barrels per day due to limitation in available feedstock competing for food production.[51] Producing just 200,000 barrels per day would require an area equal to about ten percent of the croplands currently under cultivation in the United States.[52] The doubling of gas mileage for the Badenoch from 4 to 8 miles per gallon, at $100 per barrel, may save $75

billion dollars a year in imported oil costs, and cut the number of convoys in half but would have left, at least in 2010, potentially 550 attacks instead of 1100 and 1500 personnel instead of 3000 injured.[53] The bottom line is that significant convoy security issues will still exist for the military even with an optimization of fuel usage in combat transportation vehicles Clearly the current path of optimizing combustion engines and alternative fuels has not resulted in any current or foreseeable future technological breakthroughs. Therefore, serious consideration must be given to a new paradigm shift in the investigation for alternative sources of transportation fuel.

Section 5: A Revised Governance Framework towards Energy Transportation Security

Subsection 5.1: Overview and Structure

Having evaluated the economic and security difficulties associated with the current energy transportation policies and initiatives, consideration must be given for a different model to solve the transportation energy crisis. The proposed solution includes a different type of governance board to focus and align the efforts of the many government agencies, academia, and private sector groups involved in transportation energy. This board would have three organizations below them: 1) a research and development institute similar in structure and function as the National Institute of Health[54], 2) a review committee that recommends which projects would go forward from proof of concept to large scale product development and 3) an implementation

component that will help bridge the “valley of death”[55] which is the financial and policy gap between proof of concept and a commercial product. [56]

The entire Federal Government, to include DoD and DOE, has numerous organizations working on the optimization of combustion engine technology, alternative energy and renewable energy for transportation. One estimate has the existing federal energy innovation structure crossing eleven agencies and departments with 143 different programs making coordination and optimization of efforts difficult.[57] A Council on Energy Security should be established as the umbrella organization for the various energy organizations and initiatives In order for this Council to have the muscle to move initiatives from basic research and development to commercial product, the Council would be mandated by the President with the Vice President as the Chair as suggested by Gilbert and Perl.[58] Also as suggested by the same authors, the Council would include members of the Secretary of Defense, Energy, Treasury, and Transportation as well as the Office of Management and Budget (OMB).[59] Members from State and Local Governments as well as experts from Academia and Industry would also be included into this Council.[60]

The key functions of this Council would involve developing strategy, policy and policy guidance implementation for energy transportation. Developing strategy must be national security driven. The debate on the amount of oil availability in the next twenty to thirty years, as well as environmental and health issues from fossil fuels will always divide this country. Goals associated in the name of national security have always received bipartisan political support and approval by the American public. A key component of the strategy must be to accelerate to the market those innovations that

will bolster our economic growth while eliminating this country's dependency on oil for transportation fuel. Policies must specifically articulate the path forward to achieve the objectives of the strategy. Most importantly, these policies must be championed by the Vice President and adequately funded for full implementation On too many occasions, policies through Executive Orders (EO) have taken a back seat due to competing departmental priorities, funding allocations, and shifting leadership emphasis.

The United States must develop policies and pass legislation that first increases research and development on a wider array of transportation technology alternatives than those that are currently being investigated as well as encouraging partnerships between the public and private industry to overcome the "valley of death" that prevents new innovations from going forward into the market. Weiss and Bonvillian call these two strategies "front load" which provides support for basic research, development, and demonstration and "back load" which provides for government support for implementation through incentives or regulatory standards to move the technology to the commercial production phase.[61]

Three subgroups would be formed to support and implement the strategy and policies of this Council on Energy Security. These subgroups would include: 1) a Research and Development Group modeled after the National Institute of Health, 2) an Assessment Group to decide which projects should go to large scale prototypes and commercial production and an 3) Implementation Group that would be charged with partnering with private industry to bridge the "valley of death" to bring those innovations to the marketplace.

Subsection 5.2: Research and Development Group

Basic Research and Development is the cornerstone of any technological breakthrough and is best performed by research universities and federal laboratories. Ideas must be initially examined without any fiscal or policy constraints so that all the possible solution sets may be examined. Too often failure is not tolerated when the outcome does not meet expectations. As a society, we are too impatient and must learn that these "failures" often spring other ideas that could lead to technological breakthroughs. Creating an umbrella organization such as a National Institute of Energy (NIE), modeled after the successful National Institute of Health,[62] would be able to focus a concentrated effort by leading universities and national laboratories to unleash their talents in exploring technological advances. The NIE would have a singular mission to fund and conduct groundbreaking energy research throughout the United States.[63] Unlike NIH, however, NIE would also assist in focusing on ultimately commercializing new innovation that have reached the large prototype or commercial production stage, and not just securing patents and publishing research papers.[64]

Increasing research and development funding in today's fiscally constrained environment may not be popular but necessary given the current national security environment. In 2010, the United States budget was $3.6 trillion with only $5.1 billion for energy research and development (1.34% of the budget).[65] In contrast, China announced in July 2010 that it will invest a total of $738 billion over next 10 years in just clean energy research, development, deployment and associated infrastructure. [66] The medical and biotechnology field research and development funding in the United States

is roughly 15% of sales which is almost a staggering forty times the amount spent in the energy field.[67]

While 15% of sales may not be feasible, recommendations for increasing the amount of basic research and development has been three to seven times the current level to $15 to $35 million dollars.[6869] Many leading publications and books have provided many options on increasing funding for research and development. Some of these alternatives include: 1) redirecting or reducing current subsidies provided to the oil, gas, and coal industry[70], 2) redirect or increase the gasoline tax[71] or 3) utilize the revenue from a greenhouse cap and trade policy[72]. Political infighting within both parties has made a greenhouse gas cap and trade policy a nonstarter. However, given the record profits made by the oil companies in the last decade (Exxon Mobil revenue was $30.46 billion for 2010)[73], the redirecting or reducing of current subsidies would be the best option to increase funding without raising taxes or introducing complex regulations. From 2011 through 2015, the federal government will provide over $31 billion in subsidies for the oil and gas industry and $19.2 billion for the coal industry.[74] These funds, administered by the NIE, could be better suited for universities which focus on pure rather than applied research in a nonprofit environment.

Subsection 5.3 Assessment Group

The various technologies coming out of the Research and Development group would then be evaluated by the Assessment Group to determine which projects go from proof of concept to large prototype as well as from large prototype to commercial development. Selected candidate technologies would move forward based on a set

criterion that have the best possibility in meeting the Council's goal. The fully burden cost of fuel must also be considered before a large prototype project is approved. The Assessment Group would consist of a subset of the Council representing government agencies, academia, and the private sector. Given the private sector's uneasiness of investing large capital without a sure short return on investment, the large prototypes would be mainly funded by the federal government. As such, the main voice on projects moving to this stage of development should be the federal government. Project performance should be reviewed and validated on a cyclical basis.

Conversely, as the Assessment Group reviews and validates technologies that are to be moved from large prototype to commercial development, the deciding opinion should be from private industry which will be in the best position to determine the most economical technology that can be utilized. However, government agencies must also approve of those innovations to ensure that a technological monopoly does not occur resulting in an increased risk to national security. Private industry is not in the business of commercializing technologies that serve the public good [75] [76] and is therefore the role of government to ensure this is also captured in any technology they fund.

Subsection 5.4: Implementation Group

As innovations are approved for transfer and exploitation, the Implementation Group will be responsible to bring these technologies to full commercial development in conjunction with the private industry. While private industry may have a large input on the commercialization process, it will take experienced government agencies to bridge

this “valley of death” portion of development. The lead for this Implementation Group should come from the two Departments that have the best record for bridging the “valley of death”: The Department of Defense’s Defense Advanced Research Projects Agency (DARPA) and the Department of Energy’s Advanced Research Project Agency-Energy (ARPA-E). The agency with the best track record in successfully bridging this “valley of death” has been DARPA. Throughout history, DARPA has demonstrated that the more the military adopted a particular technology the more momentum it gained, the more constituents pushed for it, the more policymakers awarded it with further R and D contract the more the innovation improved[77] ARPA-E has been modeled after DARPA to focus on energy related challenges and would be an excellent energy focused complement to DARPA. With DoD having the largest procurement system and DOE the energy expertise, the combination of these two organizations would ideally work with private industry to bring the best technologies to the market that would serve both the public good and economic value.

Subsection 5.5: Funding Alternatives

A key component for both the Assessment and Implementation Group is the structure of funding for technologies going forward to the next stages. As discussed by Bonvillian and Weiss, funding should begin as technologically neutral to prevent undue influence on the progression of these innovations.[78] The federal government’s role in this process would be to provide legislation standard packages of incentives and support across common technologies rather than the current process of legislating for a

unique policy for a particular technology allowing the optimal technology to succeed.[79] The current practice of subsidizing the deployment of a new specific energy technology, like ethanol by their associated lobbies, stifles innovation to only a very specific field.[80]

Funding for these large projects may include several economic and regulatory options. The literature has determined that the United States needs to increase this funding to a minimum $15 to $25 billion dollars a year.[8182] [83] Since projects take at least 10 years to develop and at least 10 to 70 years for market penetration, [84]private industry would like some assurance for their investment which requires that funding be locked for at least a decade. As discussed earlier, reducing oil, gas and energy subsidies may also level the energy playing field when it comes to bridging the "valley of death". Currently, transport is dominated by a single energy source in oil which has a built in infrastructure[85] that subsidies its cost versus alternative and renewable energy sources.[86] Redirecting subsidies to this action would make private industry more likely to become heavily involved.

The literature has several other funding options for bridging the "valley of death". One idea is to create tax credits[87] that increase deductions from 14% to 50% of qualified expenditures to include capital investments [88] for those companies willing to invest in large prototypes or commercialized innovations. Another initiative would to continue the Advanced Energy Manufacturing Tax Credit[89] with an additional $5 billion as outlined in President Obama's January 24, 2012 State of the Union address to assist in building and improving technologies.

Finally, an increase of five cent per gallon of imported oil should be implemented to fund both R & D and the "valley of death" requirements. At the current consumption of 1.5 billion barrels a year (42 gallons per barrel); this increase would generate over $3 billion of funding a year. Each year the amount should increase one cent per gallon to generate a constant stream of revenue while hopefully decreasing the amount of oil imported per year.

Subsection 5.6 Trade Policy Initiatives

In order to compete in the global market, the United States must enact trade policies that assist American companies in promoting new innovations. In particular, the United States needs access to overseas markets by strengthening export promotion and protection programs.[90] Other countries already have in place policies that protect their energy markets. .China is an example where American companies are locked out of the renewable energy market. In China, for a foreign company to sell electric vehicles, a Chinese company must be "involved" in the most valuable part of the vehicle: battery, motor, or power electronics.[91] In the area of rare earths, which are needed as components for batteries, Chinese corporations, with government assistance, has attempted to acquire control of two large rare earth companies, Unocal of the United States and Lynas Corporation of Australia.[92] Both of these attempts failed due to national security concerns rather than current trade policies.[93] The result of these Chinese and other nations' policies is that the United States is facing a $6.4 billion clean energy trade deficit which has economical as well as national security issues.[94]

American trade policy should also require and encourage that most of the important components and assembly of United States technology be performed within the United States. This should not be different if it is for energy or other technologies. The United States should also aggressively promote American technology abroad through the U.S. Trade Representative to lower tariffs on American goods.[95]

Section 6: Conclusion: The Way Ahead – "Forging a Bold Alliance" Now

The current direction of optimization of combustion engines, alternative fuels, and conservation measures have not appreciably improved the national security of the United States. The country will continue to import a significant amount of oil each year while increasing consumption. In fact, only modest improvements can be hoped for in the next ten to thirty years. Given this lack of success, the time has come to boldly change the business models and governing framework on how energy innovations are brought to market. Without taking a new direction in transportation energy , the United States may face a new world order on energy security as a consumer of technology imported from foreign competitors resulting in a missed opportunity at job growth, a significant decrease in the standard of living and a decline in military readiness and our national security.

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